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Interest Rate Linkages in the Pacific Basin

Reuven Glick*

Empirical estimates indicate that the degree of linkage between domestic real interest rates in Pacific Basin countries and that of the United States is comparable to the linkage between most European countries and the United States. Financial liberalization and other developments that have affected the determination of interest rates in the Pacific Basin region also are discussed.

The relation among real interest rates in different countries is an important issue for policymakers since the effectiveness of stabilization policies is determined largely by the extent to which domestic monetary and fiscal authorities can influence the domestic real rate relative to the world rate.

While a number of studies of interest rate linkages between the U.S. and European countries exist (von Furstenberg, 1983; Mishkin, 1984a, 1984b; Cumby and Obstfeld, 1984; and Cumby and Mishkin, 1986), similar studies for other parts of the world, particularly the developing regions, are scant (see Blejer and Khan, 1983). This relative neglect often has been justified by the rationale that competitive forces have played little role in the determination of interest rates in most other countries, and that controls and other market barriers impeded the development of any linkages.

With the recent liberalizing financial trend in many countries, however, particularly in the Pacific Basin, this rationale no longer seems justified. Moreover, as shall be discussed below, while barriers to international financial flows may prevent real interest rates from being equalized, linkages between rates in different countries may still exist.

The major purpose of this paper is to examine the extent to which domestic real interest rates in Pacific Basin countries have been linked to rates in the United States in recent years. The paper is organized as follows. Section I discusses factors affecting the relation of real interest rates among countries. Section II summarizes specific financial liberalization developments in the six countries examined in the empirical section of the paper: Hong Kong, Singapore, Malaysia, Japan, Taiwan, and Australia. These countries were chosen because each possesses a sufficiently long time series of a market-influenced interest rate.

Section III empirically analyzes relationships among real rates in the countries under study. This section first describes the methodology of generating estimates of *ex ante* real rates and of measuring the extent to which these rates are related to that of the United States. The methodology of Cumby and Mishkin (1986) is employed to obtain consistent estimates from *ex post* observations of real rates. It then presents and discusses the empirical results. Section IV provides a brief summary of conclusions.

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I. Theory of Real Interest Rate Linkage

A country's real interest rate is equal to its nominal interest rate minus the expected rate of inflation. The relation of real interest rates between two countries thus depends on the relationship of nominal interest rates through the interaction of their financial markets, on the relationship of price levels through the interaction of their goods markets, and, since their price levels are denominated in different currencies, on the exchange rate between their currencies.

To see this, define the *ex ante* foreign and U.S. real interest rates by

$$rr_j = i_j - \hat{p}_j^e \text{ and } rr_{us} = i_{us} - \hat{p}_{us}^e \qquad (1)$$

where rr_j (rr_{us}) and i_j (i_{us}) represent for country j (the U.S.) the expected real and nominal rates of return, respectively, at time t earned by holding the asset from time t to t + 1, and $\hat{p}_j^e$ ($\hat{p}_{us}^e$) denotes the expectation at time t of the inflation rate from t to t + 1, where time scripts are omitted.

Let s denote the nominal foreign exchange price of the dollar, p_j (p_{us}) the foreign (dollar) price of foreign (U.S.) goods, and $q = sp_{us}/p_j$, the real foreign price of the dollar. Note that a *rise* in s represents an increase in the amount of foreign currency necessary to buy a dollar and hence a *nominal foreign currency depreciation* or, correspondingly, a nominal appreciation of the dollar. A *rise* in q represents an increase in the relative foreign currency price of U.S. goods and hence a *real foreign currency depreciation* or, correspondingly, a real dollar appreciation. A real foreign depreciation occurs when a rise in nominal foreign currency value of the dollar and in U.S. prices exceeds the rise in foreign prices.

Adding and subtracting appropriately and using the definition of the U.S. real rate implies

$$\begin{aligned} rr_j &= i_j - \hat{p}_j^e + i_{us} - i_{us} + \hat{s}^e - \hat{s}^e + \hat{p}_{us}^e - \hat{p}_{us}^e \\ &= rr_{us} + (\hat{s}^e + \hat{p}_{us}^e - \hat{p}_j^e) + (i_j - i_{us} - \hat{s}^e) \\ &= rr_{us} + \hat{q}^e + (i_j - i_{us} - \hat{s}^e) \qquad (2) \end{aligned}$$

where $\hat{q}^e = \hat{s}^e + \hat{p}_{us}^e - \hat{p}_j^e$ denotes the expected change in the real exchange rate.

Equation 2 states that real interest rates may differ between countries because of two factors given by the last two terms on the righthand side of the expression. The first of these terms represents expected deviations from purchasing power parity (PPP) or, equivalently, expected real exchange rate movements. According to PPP, the nominal exchange rate is anticipated to change according to the anticipated differential in rates of inflation, leaving the real exchange rate constant. Thus, when foreign inflation exceeds U.S. inflation, a foreign currency depreciation is necessary to sustain purchasing power parity between foreign and U.S. currencies.

The last term represents deviations in uncovered interest parity (UIP). According to UIP, the anticipated rate of depreciation of the foreign currency should equal the nominal interest differential (presuming U.S. and foreign assets are otherwise comparable). Thus, an anticipated foreign currency depreciation should lead to a higher foreign interest rate to compensate for the expected currency loss associated with the anticipated depreciation, and thereby leave the overall return to investing in foreign assets equal to that from investing in U.S. assets.

The existence of deviations from PPP and UIP depends on a number of factors. Barriers to international trade may create PPP deviations by limiting the ability of goods market arbitrage to link domestic and foreign inflation rates and the exchange rate. PPP may not hold, even in the absence of goods market trade barriers, when domestic and foreign goods are not perfect substitutes. Moreover, deviations from PPP may also occur because of various factors affecting the equilibrium real exchange rate. Differential changes in taste, technology, or factor supplies can permanently influence relative price competitiveness among countries and therefore the real exchange rate between them. In addition, changes in monetary and fiscal policy and other economic demand and supply shocks can lead to fluctuations in real exchange rates and hence deviations from PPP.[1] To the extent that the effects of these policy changes average out over time,

however, the magnitude of this cause of real interest differentials diminishes.

Restrictions on international capital flows can inhibit the ability of financial market arbitrage to link domestic and foreign nominal interest rates and the exchange rate and thereby create deviations from UIP. UIP may not hold precisely even in the absence of financial market imperfections when domestic and foreign assets are not perfect substitutes. In this case, deviations would arise from the risk premium necessary to compensate investors for holding the asset with the higher risk.

To summarize, real interest rates are equal across countries only in the absence of deviations from PPP and UIP. They may differ because of deviations from PPP and/or UIP. Thus, for example, the foreign real rate can be below that in the U.S. in the case of an expected real appreciation of the foreign currency ($\hat{q}^e < 0$), a deviation from PPP, or because the foreign nominal return is less than the dollar equivalent return ($i_j < i_{us} + \hat{s}^e$), which is a deviation from UIP.

II. Pacific Basin Experiences

The discussion of the previous section implies that the degree of international linkage of real interest rates depends on the degree of integration of financial and goods markets as well as on expected changes in the real exchange rate. In recent years, the majority of countries in the Pacific Basin have undertaken steps to liberalize their domestic financial systems and to remove restrictions on international capital flows.[2] At the same time, these countries have been subject to various domestic and foreign disturbances that have influenced their real exchange rates. These disturbances include oil price changes, commodity export price shocks, and foreign economic policy changes, such as the U.S. fiscal expansion of the 1980s.

Since the process of financial liberalization has been the foremost economic development within most countries in the Pacific Basin region during the 1970s and 1980s, the individual experiences of the six countries examined in the empirical portion of this paper are briefly discussed below. These countries include: Hong Kong and Singapore, which liberalized earliest, in the early to mid-1970s; Malaysia and Japan, which began liberalization somewhat later, in the late 1970s; and Australia and Taiwan, which did not begin liberalization significantly until the 1980s.[3]

Hong Kong

Hong Kong has been one of the least restricted economies in the Pacific Basin. It formally abolished its last official exchange controls in December 1972, and, in general, now imposes no controls on international capital receipts or payments by residents or nonresidents.

Over the period 1979 to 1983, Hong Kong's financial system was subject to a number of changes. In February 1979, the government required the major note-issuing banks to back all reserve assets with either currency or foreign exchange assets. In April 1981, the banking system was restructured and withholding taxes on domestic assets were eliminated. In February 1982, withholding taxes on foreign currency deposits were abolished as well. In October 1983, interest withholding taxes on Hong Kong dollar deposits were eliminated, and the Hong Kong dollar, which had been allowed to float freely since November 1974, was pegged to the U.S. dollar. In addition, in the early 1980s, considerable uncertainty about the political future of Hong Kong occasionally influenced financial markets.

Singapore

Singapore began deregulating the pricing of most of its financial markets in July 1975 and completely liberalized foreign exchange transactions in June 1978. In principle, near perfect international capital mobility exists: residents are free to make transactions in any currency as well as to invest in any currency. While nonresidents are similarly free to

transact in Singaporean dollars, the authorities have sought to some extent to segment domestic money markets from the Asia dollar market — an offshore currency market where rates are freely determined (this practice differs from that of Hong Kong, which has not sought to limit nonresidents' use of local currency).

In addition, there is some historical evidence that on occasion Singapore has sought to limit the effects of U.S. interest rates on domestic rates by "moral suasion" (see Fry, 1985). Since 1975, the Monetary Authority of Singapore has officially pegged the Singaporean dollar to a trade-weighted basket of currencies.

Malaysia

Malaysia followed Singapore in the pursuit of a policy of financial deregulation. Starting in August 1973, certain nonbank interest rates were freed, and steps were taken to create more effective competition among commercial banks. In addition, the currency was allowed to float. In October 1978, measures were announced that reduced the extent of administrative guidance, that made bank interest rates more market-oriented, and that introduced several new instruments, such as bankers' acceptances and CDs. These steps significantly increased the responsiveness of deposit rates to the interbank rate. However, despite the fostering of price competition, allocative requirements on bank loans are still regularly imposed and priority sectors are favored with low interest rates.

Malaysia has a system that is generally free of exchange controls; its authorities impose virtually no restrictions on capital inflows or on capital outflows as long as they are not financed by local borrowing. However, the public is prohibited from dealing in foreign exchange unless there is an underlying "genuine" trade transaction. Moreover, commercial banks, which form the core of the foreign exchange market, are limited in the open positions they may undertake in foreign exchange transactions.

Japan

Japan has followed a gradual process of deregulation of both domestic and international financial transactions since the mid-1970s, including lifting interest rate ceilings and controls on international capital flows. In May 1979, foreigners were allowed for the first time to acquire gensaki securities — three-month repurchase agreements traded on one of the few markets in Japan with competitively determined interest rates.[5] Japanese banks were allowed to make short-term foreign currency loans to residents (impact loans) in June 1979 and long-term loans in March 1980. By freeing all international transactions, in principle, from direct government influence, amendments to the Foreign Exchange and Foreign Trade Control Law in December 1980 officially recognized the gradual process of de-control of capital flows that had already taken place. Nevertheless, the government has periodically used "moral suasion" to limit international capital transactions.

Efforts by the United States to induce the Japanese government to adopt a list of measures further liberalizing its capital markets resulted in the May 1984 Yen/Dollar Agreement. Subsequent reforms that have further facilitated increased international capital flows include the end of yen-dollar swap limits for foreign banks operating in Japan and the removal of the requirement that all forward exchange transactions be related to export and import merchandise transactions or remittances in June 1984.

Taiwan

Taiwan has been somewhat slower than the countries above in pursuing financial reform, although it too began establishing open money markets in the late 1970s. In April 1980, Taiwan relaxed official restrictions on bank lending rates. The rates are currently set by a bankers cartel, the Taipei Bankers' Association, which allows somewhat more flexible rate adjustment. In November 1980, more flexible interest rate adjustment was permitted on other bank instruments, including negotiable CDs and debentures.

Even as Taiwan has liberalized these aspects of its financial market, it has kept international capital movements greatly restricted. In December 1978, residents were permitted to hold foreign exchange deposits in designated banks and to buy and sell

foreign exchange through these banks. In February 1979, a foreign exchange market in which the exchange rate was allowed to float within pre-set limits was established. (The exchange rate was devalued in July 1978; a further devaluation occurred in August 1981.) In practice, the exchange rate is set by a small group of commercial banks together with the Central Bank.

Australia

Australia has only recently liberalized its financial markets although, in contrast to Taiwan, undertook reforms in quick succession. Not until December 1980 were some interest rate ceilings and quantitative guidelines on bank lending removed. However, by December 1983, Australia had floated its currency and abolished almost all foreign exchange controls.

III. Analyzing Real Interest Rates

In this section, we analyze real interest rate linkages between the United States and six Pacific Basin countries — Hong Kong, Singapore, Malaysia, Japan, Taiwan, and Australia. These countries were chosen because each possesses a domestic financial market that has been free enough to provide meaningful interest rate statistics. A comparison of findings involving these countries with those for developed countries provides useful evidence of the extent of international integration of asset and goods markets within the Pacific Basin.

Tests performed for the U.S. and other major industrial countries by Mishkin (1984a, 1984b), von Furstenberg (1983), Cumby and Obstfeld (1984), Mishkin (1984a, 1984b), and Cumby and Mishkin (1986) generally reject the hypothesis that real interest rates are equalized across countries.[6] However, Cumby and Mishkin have measured the extent to which real rates in the U.S., Canada, and Europe are linked and move together over time. They find that real rates have climbed dramatically from the 1970s to the 1980s in the U.S. and abroad, and that there is a significant positive association between movements in U.S. real rates and those abroad. This strong and statistically significant tendency for real rates to move together in different countries, even though the movement is not one-for-one, suggests that some degree of international linkage exists among the countries.

We proceed by discussing the econometric methodology of the tests employed, which were based on the work of Cumby and Mishkin (1986). As Cumby and Mishkin point out, the major difficulty in such tests is that the expected inflation rate, and hence the *ex ante* real interest rate, is unobservable. One must therefore take care in making statistical inferences about *ex ante* real rates from observed data. The methodology is described more fully below, and empirical results follow.

Methodology

Restating definition 1, the *ex ante* real interest rate associated with a given asset at time t is given by

$$rr = i - \hat{p}^e, \tag{3}$$

where i and rr represent the nominal and expected real rates of return, respectively, at time t earned by holding the asset from time t to t + 1, and $\hat{p}^e$ denotes the expectation at time t of the inflation rate from t to t + 1. The *ex post* real rate can be calculated by subtracting from the nominal interest rate the *ex post* inflation rate

$$eprr = i - \hat{p}, \tag{4}$$

where eprr represents the realized real return to holding an asset from t to t + 1, and $\hat{p}$, the *ex post* rate of inflation.

Relationships 3 and 4 imply that the *ex ante* real rate can be expressed as

$$rr = eprr + (\hat{p} - \hat{p}^e) = eprr + \varepsilon \tag{5}$$

where $\varepsilon = \hat{p} - \hat{p}^e$ represents the forecast error of

inflation. Thus the *ex ante* and *ex post* real rates differ only because of inflation forecast errors.

Since *ex ante* inflation expectations cannot be observed, *ex ante* real rates cannot be determined directly from the calculation of *ex post* rates. However, by inferring information about the relationship between expected inflation and other variables known at time t, it is possible to generate results about the *ex ante* real rate from regressions involving only *ex post* data.

More specifically, assuming rational expectations, that is, that expectations of future inflation at time t depend on all available information,

$$\hat{p}^e = E[\hat{p} \mid \theta] \tag{6}$$

and hence

$$E[\varepsilon \mid \theta] = 0, \tag{7}$$

where θ = all available information at time t. In other words, the forecast error of inflation is uncorrelated with any information available at time t. Correspondingly, 5 and 7 imply

$$rr = E[eprr \mid \theta] \tag{8}$$

that is, the *ex ante* real rate is given by the expected value of the *ex post* rate conditional on the information set θ or, equivalently, by the fitted linear regression relationship between the *ex post* rate and θ.

To take account of the fact that an econometrician does not know all the information available to agents, assume that the *ex ante* real rate formed at time t is linearly correlated with variables in the set X that can be observed by an econometrician at time t and are contained in the available information set θ. This implies

$$rr = XB + u, \tag{9}$$

where B is a vector of coefficients and u is a measurement error term such that $E[u \mid X] = 0$.[7] Because rr is not observable by an econometrician either, equation 9 cannot be estimated directly. However, substituting equation 9 into equation 5 and re-arranging gives

$$eprr = XB + (u - \varepsilon) = XB + \eta \tag{10}$$

which, because both eprr and X are observable, can be estimated by ordinary least squares. Estimates of the *ex ante* real rate can then be obtained from the fitted values of this regression.[8]

The tests of interest rate linkage are constructed from the hypothesis

$$rr_j = a_j + b_j rr_{us} + \omega_j \tag{11}$$

where rr_j denotes the *ex ante* real rate in country j, rr_{us} that in the U.S., and ω_j is an error term. The hypothesis of equal real returns implies $a_j = 0$ and $b_j = 1$, while the hypothesis that there is no link between rates implies $b_j = 0$. Partial linkage is indicated if $0<b_j<1$.

Because the *ex ante* real returns are not observed, this regression equation cannot be estimated directly. However, using the expression for the *ex post* real rate in equation 5, one can rewrite equation 11 as

$$eprr_j = a_j + b_j eprr_{us} + (\omega_j - \varepsilon_j + b_j \varepsilon_{us}), \tag{12}$$

which depends only on observables. However, because the error term $\omega_j - \varepsilon_j + b_j\varepsilon_{us}$ is not uncorrelated with the explanatory variable $eppr_{us}$ ($eprr_{us}$ is realized at time t + 1 and is thus correlated with ε_{us}), an instrumental variables estimation method is necessary to obtain consistent estimates.

Consistency requires that the instruments used to estimate the *ex ante* U.S. real interest rate be uncorrelated with the error components in equation 12 — the inflation error terms in the foreign country and the U.S., ε_j and ε_{us}, and the linkage error ω_j. Choosing the instruments from the available information set θ implies by definition that they are uncorrelated with the expectational errors, ε_j and ε_{us}. To ensure that they are also uncorrelated with the linkage error ω_j, it is necessary to choose instruments that exert no additional influence on the interest rate in country j apart from their influence on the real rate in the U.S. As suggested by Cumby and Mishkin, a natural choice for instruments that satisfy these requirements are those variables in X that predict the U.S. *ex post* real rate well.

Empirical Results

The sample range in the empirical analysis consisted of quarterly data over the period 1974QIV to 1986QI (to 1985QIV for Malaysia). All data were obtained from the IMF *International Financial Statistics* or national sources. Where available, the rates used were end-of-period 90-day rates. More specifically, the 90-day Treasury bill rate was used for the

U.S., the 3-month gensaki rate for Japan,[9] and the 90-day commercial bill rate for Australia. For Taiwan, the short-term curb rate was employed,[10] and for Malaysia the overnight commercial bill rate.[11] In the case of Hong Kong, the mid-point of the low-high range of the overnight interbank rate in the last month of each quarter was used.

The variables in the information set X used instrumentally to estimate real rates in individual countries included a constant term, linear and quadratic time trend, the nominal interest rate, and three values of lagged inflation. The addition of other variables, such as money growth, was not found to provide any additional explanatory power, except for the case of Malaysia.

Quandt statistics (1960) and Chow tests were used to test for evidence of shifts in the stochastic structure of real interest rate levels. A regime shift was found for the U.S. from 1980QI to 1982QIII. This result is consistent with the findings of Huizinga and Mishkin (1986) and others of a shift in monetary policy behavior by the Federal Reserve in late 1979, with subsequent return to the original regime after the third quarter of 1982. For Japan a regime shift was found to occur in 1979QI. This shift may be identified as related to the greater focus of the Bank of Japan on monetary aggregates than on interest rates that purportedly began in July 1978 (see Hutchison, 1986).

Shifts found for other countries took place in Hong Kong in 1981QIV, Singapore in 1977QIII, Malaysia in 1980QII, and Taiwan in 1979QIV; although no significant shift was found for Australia. These shifts may be attributable to the effects of financial liberalization steps, although the cause is impossible to determine conclusively. It should be noted that these regime breaks cannot be determined precisely; breaks may have occurred before or after the periods indicated, and other breaks also may have occurred. The ones reported are those with F-statistics with less than 5 percent significance.

The final estimates of *ex ante* real rates were obtained by including in the regression equation multiplicative dummy terms for all variables in X; the dummy was set equal to 0 before the shift point

TABLE 1

Linkages with U.S. Real Interest Rates*

Country	a	b	$\bar{R}^2$	SEE	Q-sig
Hong Kong	.00 (.35)	.64 (2.62)	.17	.057	.15
Singapore	.03 (4.78)	.48 (2.86)	.33	.037	.44
Malaysia	.00 (.64)	.62 (3.49)	.30	.040	.05
Japan	.02 (3.66)	.46 (3.45)	.23	.031	.00
Taiwan	.21 (19.8)	.58 (2.46)	.70	.050	.96
Australia	.01 (1.38)	.38 (1.96)	.45	.040	.66

*T-statistics are in parentheses. All b coefficients are significantly different from 0 and 1 at the .05 level. Instruments used in all cases were a constant, the nominal interest rate in the United States, three lagged values of inflation in the United States, and time and time-squared trend variables. These variables were also included multiplied by a dummy variable that is set equal to 1 for 1980QI - 1982QIII and 0 otherwise. Intercept shift dummies included in final regressions are not reported.

and one at the shift point and after (except for the U.S. where it was set equal to 0 again after 1982QIII).

Charts 1 through 7 (appended) graph the *ex ante* real (and nominal) interest levels in each of these countries. Observe that the real interest rate appears to have risen in all cases in the 1980s in correspondence with the rise in the U.S. real rate. Note that in the case of Taiwan, interest rate levels are particularly high due to the higher transaction costs and risk associated with the interest rate measure employed — the curb rate.

Table 1 contains the results of linkage regressions for the six Pacific Basin countries with the United States. As discussed above, econometric considerations dictate the use of the information set X used to predict the U.S. real rate — a constant, linear and quadratic time trend, the nominal U.S. interest rate, and three values of lagged U.S. inflation, as well as multiplicative dummy terms involving these variables as instruments. Intercept dummy coefficients were also included for several of the countries to remove outlying observations from the sample, but are not reported.[12]

Of particular interest in Table 1 is the coefficient b that describes the amount of movement in the country's real rate for a given movement in the U.S. rate. The hypotheses that real rates are equal across countries, $a = 0$ and $b = 1$, or are fully linked across internationally, $b = 1$, are generally rejected. However, in all cases the hypothesis of no linkage between real rates in different countries, $b = 0$, is rejected as well. In all cases, the b coefficient lies between 0 and 1: Hong Kong has the highest coefficient at .64; Malaysia has a coefficient of .62; Singapore, .48; Japan, .46; Australia has the lowest coefficient, .38. Somewhat surprisingly the coefficient for Taiwan, at .58, appears somewhat high given the limited extent of financial liberalization in that country. None of the results appeared sensitive to correction for serial correlation.

It is interesting to compare these results with those obtained by Cumby and Mishkin for linkages between Canada, several European countries, and the U.S. over the period June 1973 to December 1983.[13] Using domestic money rates, they obtained figures for b of .91 for Canada, .77 for the United Kingdom, .63 for Italy, .58 for France, .52 for the Netherlands, .44 for Germany, and .16 for Switzerland. These results indicate that, for most Pacific Basin countries, the degree of linkage with the U.S. is less than that of Canada but comparable to that of most European countries.

To investigate the possibility that financial liberalization or other developments have influenced the degree of linkage over the sample period, tests for shifts in the estimated b coefficients were performed. One of the difficulties encountered in these tests is that, in most cases, the relaxation of financial controls has been gradual rather than abrupt. This makes it difficult to identify any single point in time that corresponds with a discrete change in the relationship between domestic and foreign rates. As a result, the usefulness of tests such as the Quandt statistic, which are best used for detecting the occurrence of discrete changes at particular points in time within a sample, is limited.

The approach adopted here was to introduce various dummy variables, both separately and multiplicatively, for periods of one or more quarters. The durations chosen correspond to dates on or over which financial liberalization measures were announced as well as dates on which shifts in domestic real interest rate determination had previously been identified.

Significant intercept dummies at times were found, but shifts in the b coefficients were not. Taking account of the intercept shifts and outlying observations generally improved the fit of the relationship without affecting the magnitude of the b coefficients. Thus, the analysis provided no evidence of changes in the degree of sensitivity to the U.S. real rate.

The lack of evidence of any change in the degree of interest linkage has several possible explanations. One explanation, of course, is that there may have been no actual change in the levels of linkage over the period studied. For some of the countries in the analysis, the interest rate used may have been determined relatively competitively over most of the sample period; for other countries, any change in the degree of international arbitrage may have occurred too late in the period to have been identified econometrically.

Second, the results may indicate that, while financial market liberalization has allowed domestic interest rates in most countries to be more competitively determined in relation to domestic economic conditions, remaining restrictions on international capital flows and intermittently applied government controls have effectively limited changes in the role of international factors.[14]

A third explanation lies in recognizing, as argued in Section I, that real interest rate linkages depend not only on international financial market arbitrage but also on linkages between prices in different countries through the interaction of goods markets. The latter may have masked the effects of interest rate liberalization. More specifically, it is possible that while financial market liberalization in the countries studied has resulted in smaller deviations from uncovered interest parity, thereby leading to closer real rate linkage, larger deviations from purchasing power parity associated with expected real exchange rate movements may have weakened the linkage. One can make a strong case for this possibility since, during the 1980s when the process of financial liberalization was in full swing in the countries under study, the real value of the dollar underwent a dramatic appreciation that generated a strong expectation of subsequent real dollar depreciation.

IV. Conclusion

This study has discussed developments affecting real interest rates in the Pacific Basin. In recent years, the countries in this region have allowed both domestic and foreign market forces to play a greater role in the determination of interest rates in their economies. Empirical estimates indicate that the degree of real interest rate linkage with the United States is comparable to that of most European countries. Efforts to detect any increase in the extent of this linkage over time were unsuccessful.

The result that the real interest rates of Pacific Basin countries analyzed in this study are not tied one-for-one to that of the United States implies that the monetary and fiscal authorities of these countries have some influence over their domestic real rates and some control of their stabilization policies. However, the existence of interest rate linkages indicates that, as with countries in more developed regions, economic market forces are at work integrating their financial and goods markets with those abroad. Thus, domestic economic conditions in the Pacific Basin area are sensitive to developments abroad.

Chart 1
United States Interest Rates

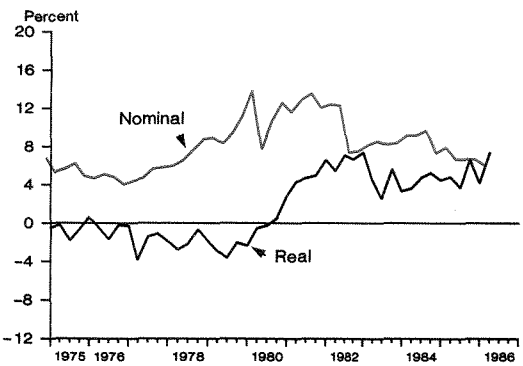


Chart 2
Japanese Interest Rates

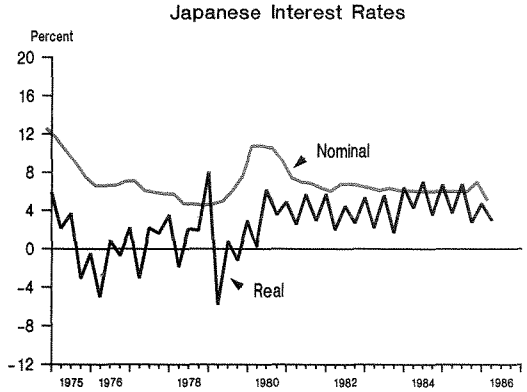


Chart 3
Hong Kong Interest Rates

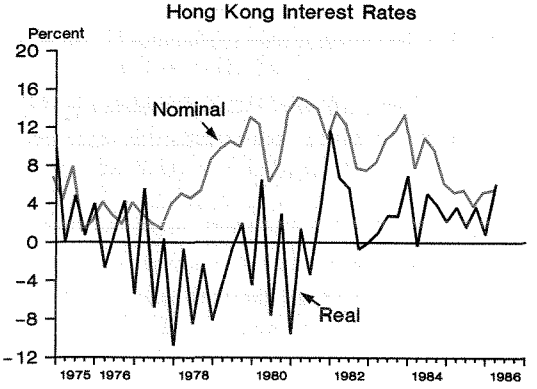


Chart 4
Singapore Interest Rates

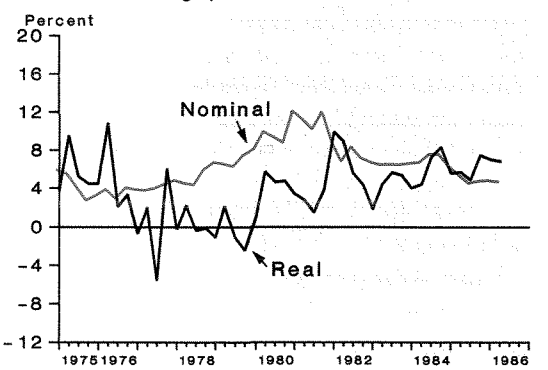


Chart 5
Malaysian Interest Rates

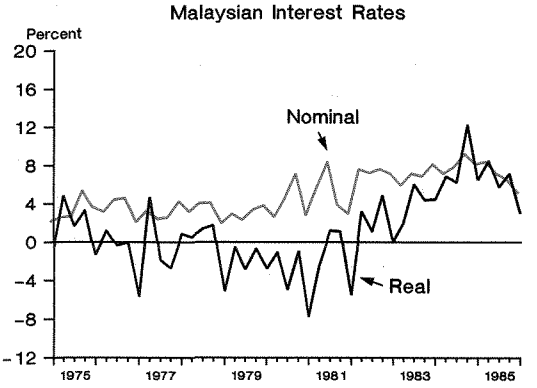


Chart 6
Taiwanese Interest Rates

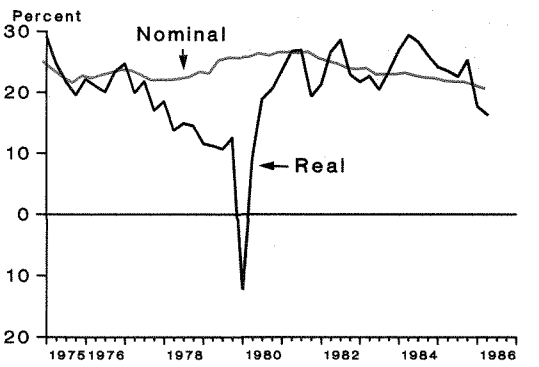
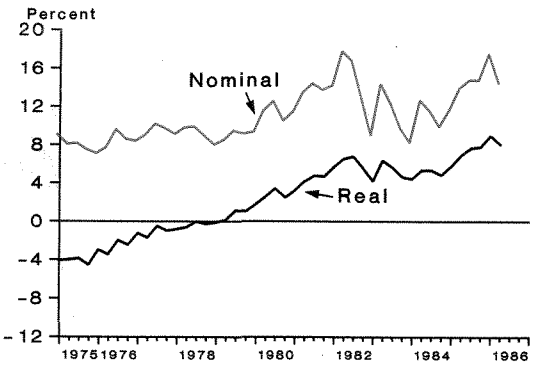


Chart 7
Australian Interest Rates



FOOTNOTES

1. Various explanations exist for the real exchange effects of disturbances. Some argue that labor and/or goods market rigidities imply that the adjustment to disturbances does not occur simultaneously, leading to short-run effects on real variables, such as real exchange rates (Dornbusch, 1976 and Obstfeld, 1985). Others attribute these effects to confusion about the source of these disturbances (Kimbrough, 1983; Flood and Hodrick, 1985; Glick and Wihlborg, 1986; Glick, 1986).

2. The appropriate order of liberalization of domestic and international restrictions is an important topic in the development economics literature. In some cases, particularly countries in Latin America, international controls were removed at the same time that domestic interest rates were allowed to rise at the very beginning of the liberalization process. Because this often resulted in large scale capital inflows (due to the return of funds involved in past capital flight in response to higher domestic rates as well as new borrowing from foreign financial institutions) that caused the domestic currency to appreciate, it has been argued that international liberalization, particularly of the capital account, should be delayed. See Edwards (1984) and Frenkel (1982). By contrast, countries in the Pacific Basin generally appear to have adopted a more gradual approach to liberalization.

3. Among other countries in the Pacific Basin, New Zealand experienced a brief period of interest liberalization between 1976 and 1981 that, after an abrupt reversal, was resumed in 1983. More cautious movements towards liberalization have occurred in Thailand. While Korea and the Philippines have also taken certain steps toward deregulation, they still continue to maintain restrictive controls on most financial transactions, particularly international financial transactions. Greenwood (1986) provides a survey of financial deregulation developments in seven East Asian countries, including Taiwan, South Korea, Hong Kong, Malaysia, Singapore, Thailand, and Indonesia. Also see Jao and Lee (1982).

4. It should be pointed out that, in general, the monetary and banking relationship between Singapore and Malaysia is not close, even though these countries were formerly one political entity, used the same currency (the Malay dollar), and had the same banking system.

5. The gensaki market evolved spontaneously in the mid-1970s with relatively little government intervention. In March 1976, Japan's Ministry of Finance formally acknowledged the existence of the gensaki market by laying down ground rules for trading. Many observers attribute Japan's policy reversal in the late 1970s, which allowed foreigners access to the gensaki and other markets, to a desire to encourage capital inflows at a time when the yen was beginning to depreciate.

6. Frankel (1986) contends that the primary source of the rejection of real rate equality for the industrialized countries is the failure of purchasing power parity since international goods market integration is far weaker than international financial market integration (or equivalently that goods in different countries are far from being perfect substitutes). However, others (Cumby and Obstfeld, 1984), have provided evidence in the case of developed countries against uncovered interest parity that is as strong as that against purchasing power parity.

7. Note that u is also in the information set θ because agents know the *ex ante* real rate even if the econometrician does not.

8. It should be noted that the regression residuals must not be heteroscedastic or serially correlated to yield correct standard errors for B. Furthermore, the estimates of rr obtained are good only when the variance of the u term is small. The variance would be small if no relevant information left out were highly correlated with X.

9. Gensaki transactions consist of the resale or repurchase of bonds at a fixed price after a fixed period, generally within 3 months. In essence, they are short-term capital transactions using bonds as collateral.

10. The curb market is an unofficial, largely unregulated financial market involving small borrowers and lenders. In the mid-1970s, the aggregate size of the curb market in Taiwan was as large as all other financial institutions put together. In 1980, it accounted for roughly 30 percent of total domestic assets (see Cheng, 1986, p. 151). Due to higher transactions costs, risk premiums, etc., the cost of funds in the curb market is substantially greater. No consistent series exist for rates on new instruments permitted in the late 1970s. Data for this series was obtained from monthly issues of the Hong Kong Monetary Authority.

11. Commercial paper rates are preferable to other interest series in Malaysia. Treasury bills are held mainly to satisfy minimum liquidity requirements and other portfolio restrictions imposed on commercial banks and other financial institutions and are sold at below-market yields. Similarly, interest rates on call loans to discount houses are influenced by the use of call loans in satisfying minimum liquidity requirements. Furthermore, the corporate bond market is extremely thin, and a consistent interest rate series is not available for the negotiable CDs introduced in 1978.

12. Individual intercept dummies were set equal to 1 for the following dates: Singapore, 75QI, 79QII; Malaysia, 75QI, 80QIV; Taiwan, 79QIV, 81QII, 78QIII-81QII; and Australia, 75QIII, 83QIV-86QI. The last dummy for Taiwan corresponds to a period of severe exchange market controls, whereas the last dummy for Australia corresponds to a period of rapid financial market liberalization.

13. The data set of Cumby and Mishkin, unlike that in this paper, involves overlapping observations. Because this leads to serially correlated errors, they use a two-step, two-stage least squares procedure developed by Cumby, Huizinga, and Obstfeld (1983). This procedure avoids problems associated with applying Cochrane-Orcutt-type techniques to models assuming rational expectations (see Flood and Garber, 1980).

14. For example, Frankel (1984) contends that, since 1979, covered interest parity through forward markets has held as closely for Japan as for the U.K., Germany, and Switzerland. By this criterion, he argues that Japan has been as open internationally as other developed countries, and disputes the claim that the Japanese still employ capital market restrictions.

However, Otani and Tiwari (1981), who analyzed capital

control distortions in the gensaki market over the period 1978QI to 1981QI, find evidence of capital flow restrictions even after such restrictions were supposedly eliminated. They found that from 1978QI - 1979QI, distortions were indeed on a declining trend — with almost no distortions from 1979QII - 1979QIV. However, they found that distortions increased in 1980QI and 1980QIII due to a Japanese government "request" that deposit institutions exercise restraint in accepting foreign exchange from the sale of foreign currency assets; distortions declined again beginning in 1980QIV. These results suggest that despite official policies, the Japanese government still retains the ability to influence capital flows when it so wishes.

REFERENCES

Blejer, M. and M. Khan. "The Foreign Exchange Market in a Highly-Open Developing Economy: The Case of Singapore," *Journal of Developing Economics,* Vol. 12, 1983.

Cheng, H. "Financial Policy and Reform in Taiwan, China," in H. Cheng (ed.), *Financial Policy and Reform in Pacific Basin Countries,* Lexington, Mass: Lexington Books, 1986.

Cumby, R. and F. Mishkin. "The International Linkage of Real Interest Rates: The European-U.S. Connection," *Journal of International Money and Finance,* Vol. 5, March 1986.

Cumby, R. and M. Obstfeld. "International Interest-Rate and Price-Level Linkages under Flexible Exchange Rates: A Review of Recent Evidence," in J. Bilson and R. Marston (eds.), *Exchange Rates: Theory and Practice,* Chicago: University of Chicago Press for the NBER, 1984.

Cumby, R., J. Huizinga, and M. Obstfeld. "Two-Step Two-Stage Least Squares Estimation Models with Rational Expectations," *Journal of Econometrics,* Vol. 21, 1983.

Dornbush, R. "Expectations and Exchange Rate Dynamics," *Journal of Political Economy,* Vol. 84, December 1976.

Edwards, S. "The Order of Liberalization of the External Sector in Developing Countries," *Princeton Essays in International Finance,* No. 156, December 1984.

Flood, R. and P. Garber. "A Pitfall in Estimation of Models with Rational Expectations," *Journal of Monetary Economics,* Vol. 6, 1980.

Flood, R. and R. Hodrick. "Optimal Price and Inventory Adjustments in an Open-Economy Model of the Business Cycle," *Quarterly Journal of Economics,* Vol. 98, August 1985.

Frankel, J. *The Yen/Dollar Agreement: Liberalizing Japanese Capital Markets,* Policy Analyses in International Economics, No. 9, Washington, D.C.: Institute for International Economics, 1984.

———. "International Capital Mobility and Crowding Out," in R. Hafer (ed.), *How Open is the U.S. Economy?,* Lexington, Mass.: Lexington Books, 1986.

Frenkel, J. "The Order of Economic Liberalization: Discussion," in K. Brunner and A. Meltzer (eds.) *Economic Policy in a World of Change,* Amsterdam: North Holland, 1982.

Fry, M. "Financial Structure, Monetary Policy and Economic Growth in Hong Kong, Singapore, Taiwan and South Korea, 1960-83" in A. Krueger, V. Corbo, and F. Corso (eds.), *Export-Oriented Development Strategies,* Boulder, Colorado: Westview Press, 1985.

von Furstenberg, G. "Changes in U.S. Interest Rates and their Effects on European Interest and Exchange Rates," in D. Bigman and T. Taya (eds.), *Exchange Rate and Trade Instability: Causes, Consequences, and Remedies,* Cambridge, Mass: Ballinger, 1983.

Glick, R. "Real Exchange Rates, Imperfect Information, and Economic Disturbances," Federal Reserve Bank of San Francisco, *Economic Review,* Fall 1986, No. 4.

Glick, R. and C. Wilhborg. "The Role of Information Acquisition and Financial Markets in International Macroeconomic Adjustment," *Journal of International Money and Finance,* Vol. 5, September 1986.

Greenwood, J. "Financial Liberalization and Innovation in Seven East Asian Economies" in Y. Suzuki and H. Yomo (eds.), *Financial Innovations and Monetary Policy: Asia and the West,* Tokyo: University of Tokyo Press, 1986.

Huizinga, J. and F. Mishkin. "Monetary Policy Regime Shifts and the Unusual Behavior of Real Interest Rates," *Carnegie Rochester Conference Series on Public Policy,* Vol. 24, 1986.

Hutchison, M. "Monetary Control, Interest Rates, and Exchange Rates: the Case of Japan, 1973-1986," Working Paper No. 145, University of California at Santa Cruz, November 1986.

Jao, Y. and S. Lee. *Financial Structure and Monetary Policies in Southeast Asia,* New York: St. Martin's Press, 1982.

Kimbrough, K. "The Information Content of the Exchange Rate and the Stability of the Real Output Under Alternative Exchange Rate Regimes," *Journal of International Money and Finance,* Vol. 2, April 1983.

Mishkin, F. "The Real Interest Rate: A Multi-Country Empirical Study," *Canadian Journal of Economics,* Vol. 17, May 1984a.

———. "Are Real Interest Rates Equal Across Countries? An Empirical Investigation of International Parity Conditions," *Journal of Finance,* Vol. 39, 1984b.

Obstfeld, M. "Floating Exchange Rates: Experience and Prospects," *Brookings Papers on Economic Activity,* No. 2, 1985.

Otani, I. and S. Tiwari. "Capital Controls and Interest Parity: The Japanese Experience, 1978-81," IMF *Staff Papers,* Vol. 28, 1981.

Quandt, R. "Tests of the Hypothesis that a Linear Regression System Obeys Two Separate Regimes," *Journal of the American Statistical Association,* Vol. 56, 1960.